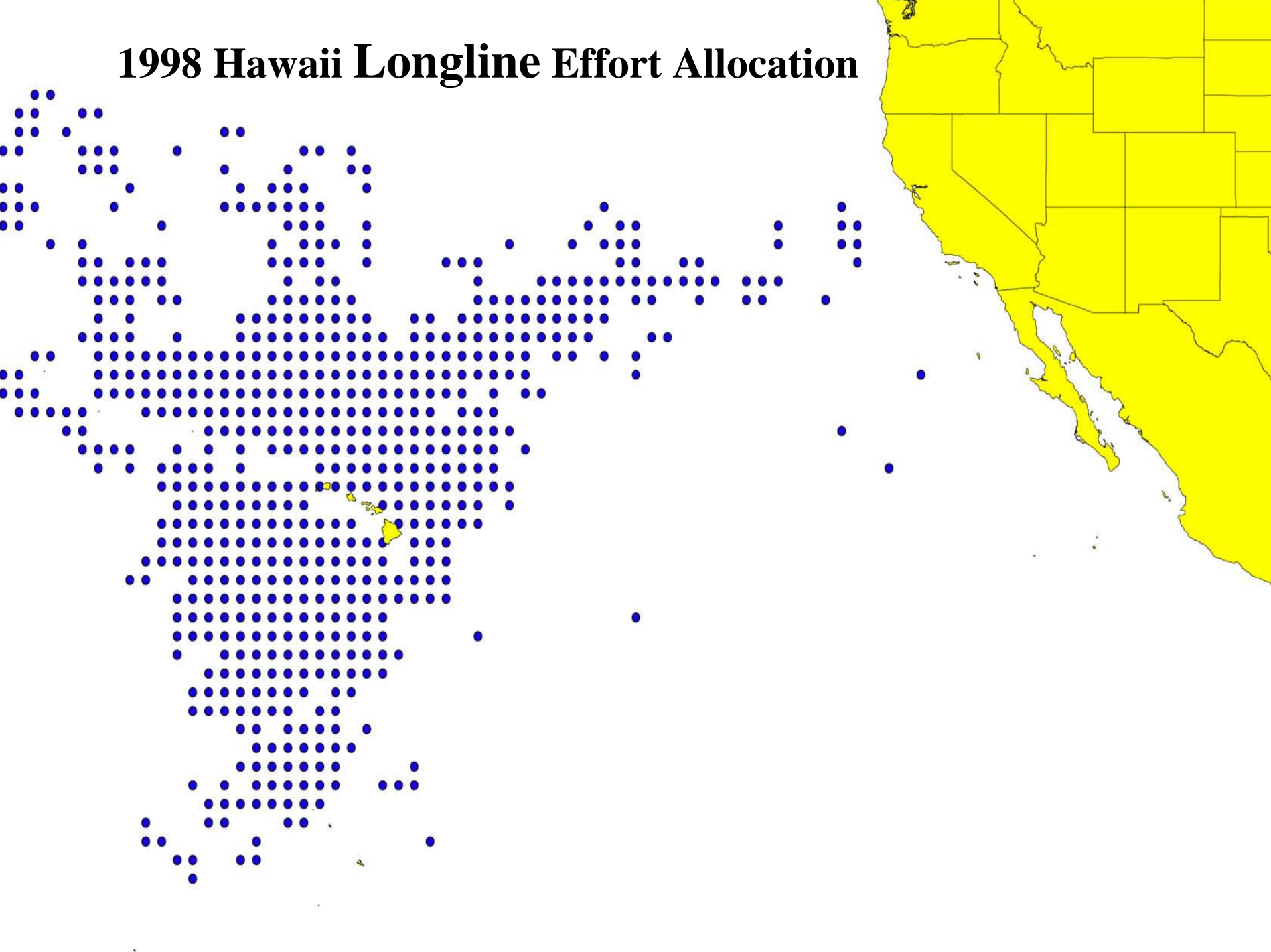# Incorporating Information & Expectations in Spatial Choice Models: Application to the Hawaii Longline Fishery

Rita Curtis, NOAA Fisheries
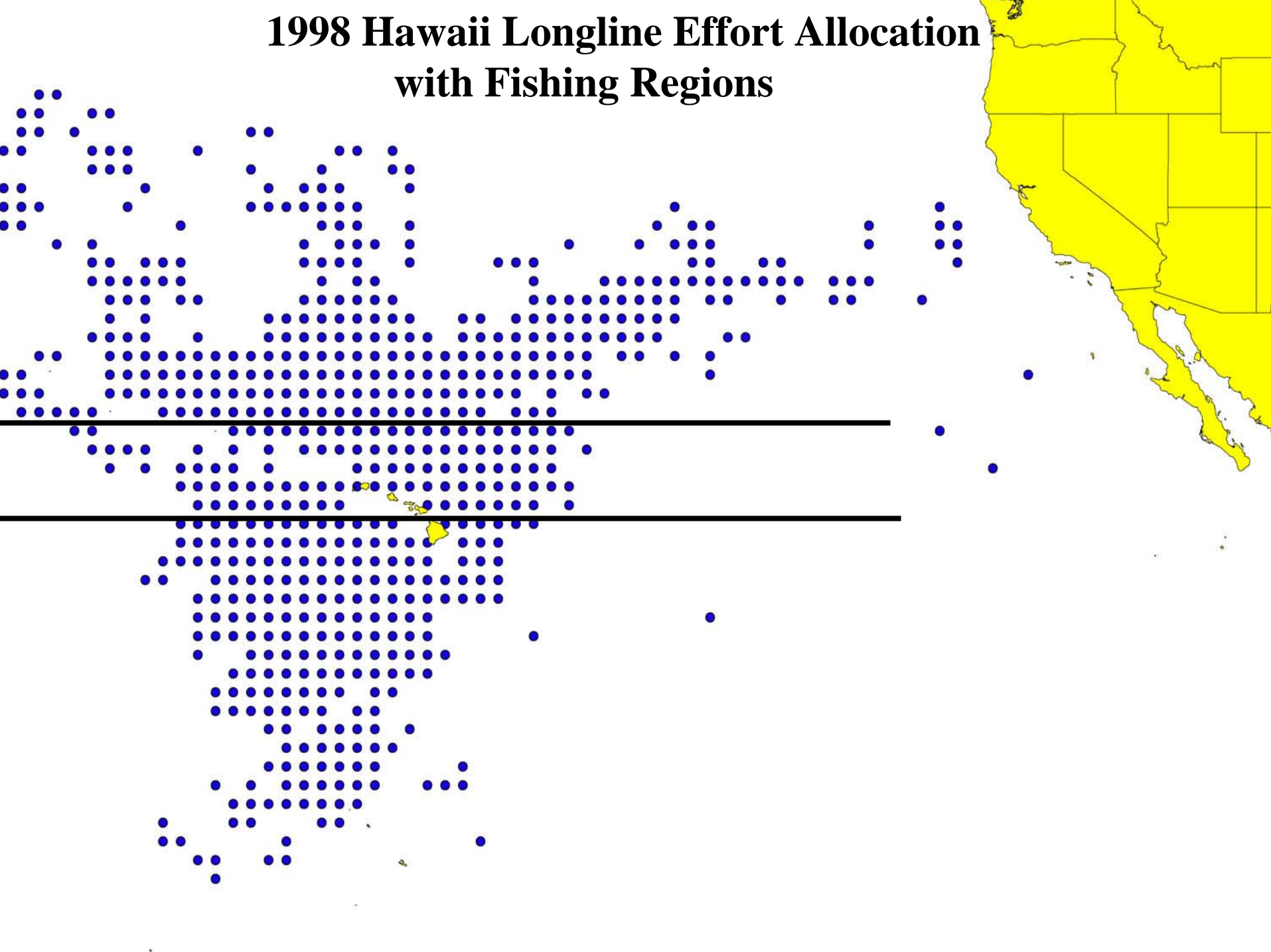**Ted McConnell, University of Maryland**
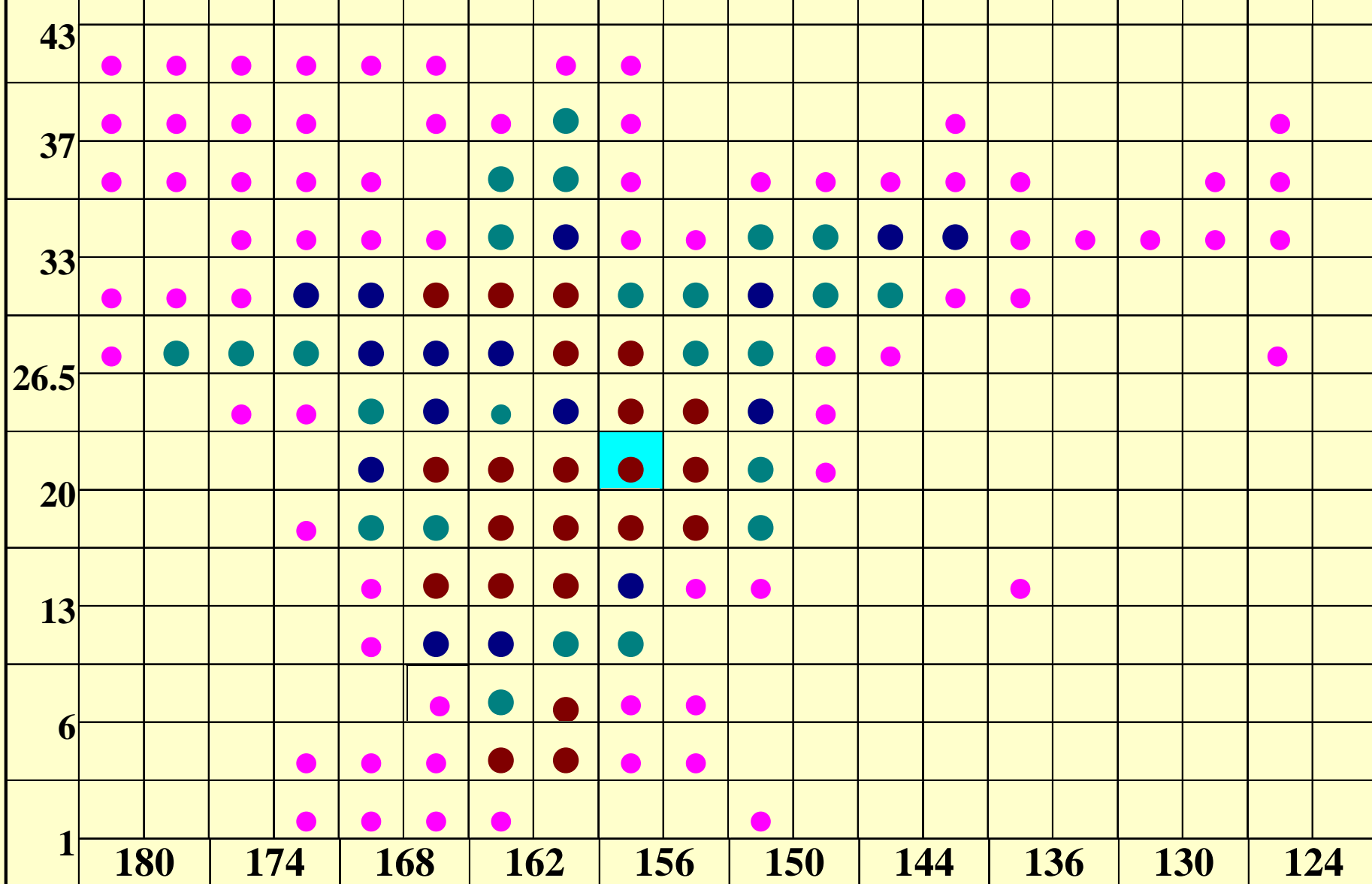
1998 Hawaii Longline Effort Allocation

Spatial model needs to be dynamic and account for multiple targeting strategies.

- Fishermen incur large costs to access distant sites that often outweigh the expected returns from single day of production. Effort allocation within fishery may be based upon **stream of returns** generated over course of a trip.

- Multispecies fisheries comprised of fish with varying value and shelf life that may also be differentially distributed across fishing grounds as well as within fishing grounds (deep water species vs. shallow water species). Foraging patterns also differ causing to occur at night or during the day depending upon species targeted.

1998 Hawaii Longline Effort Allocation
with Fishing Regions

	<30 sets		100-200 sets
● (magenta)	<30 sets	● (dark blue)	100-200 sets
● (teal)	30-100 sets	● (dark red)	>200 sets

Behavioral Model

$$EU(W)_{sfc} = EU(W_{1sfc}) + \sum_{t=2}^{T} EU(W_{tfc})$$

$$W_1 = (W_0 - FFUEL_{fc}) + REV_{sfc} - SFUEL_{sfc} - OTHERC_{sfc} - LABOR_{sfc}$$

$$W_t = (W_{t-1} - FFUEL_{fc} + ACCUMREV - CATCHDET) + REV_{fc}$$

$$- SFUEL_{sfc} - OTHERC_{sfc} - LABOR_{sfc}$$

Hawaii Longline Fishery: 1998

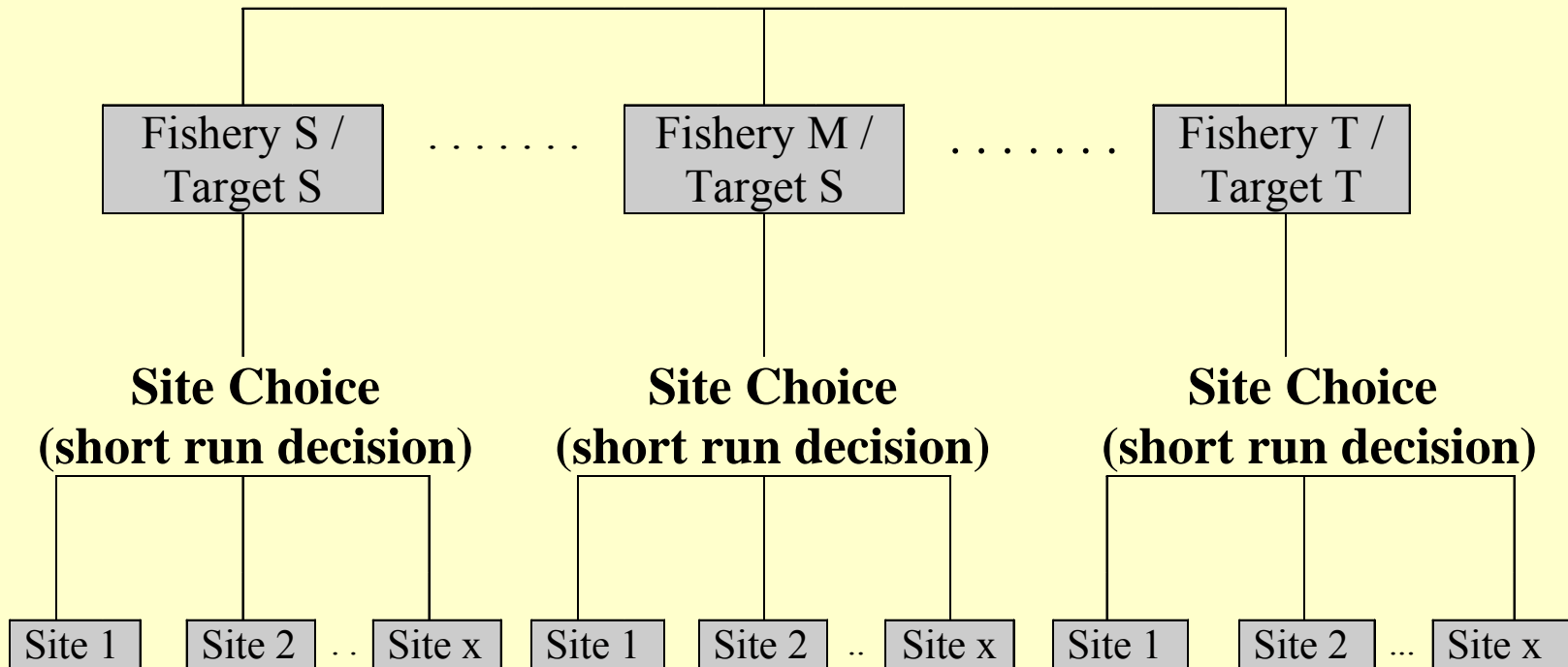|	Sword	Mixed	Tuna
Number of Sets	14	11	10
Average Set Revenue	$3340	$3212	$3643
Distance to initial site	812	552	282
Fuel Costs	$11K	$7.2K	$1.9K
Number of sites fished / trip	3.7	2.8	2.2
Catch Deterioration	$136	$882	$2832

Forecasting Returns: Model & Results

$$REV_{sfc,t} = \sum_{p=1}^{P} \alpha_{t-p} REV_{sfc,t-p} + \sum_{p=1}^{P} \gamma_{t-p} \varepsilon_{t-p} \quad \forall t = 1,...T$$

Lag Length	Swordfish	Mixed	Tuna
AR1	.671	.542	.553
AR2	.211	.288	.288
AR3		.176	.107
γ_{t-1}	.21	.22	.25

Fishery / Target Choice

(Long Run Decision)

| Fishery S / Target S | . . . . | Fishery M / Target S | . . . . | Fishery T / Target T |

Site Choice
(short run decision)

Site Choice
(short run decision)

Site Choice
(short run decision)

| Site 1 | Site 2 | . . | Site x | | Site 1 | Site 2 | . . | Site x | | Site 1 | Site 2 | ... | Site x |

$$EU(W)_{sfc} = EU(W_{1sfc}) + \sum_{t=2}^{T} EU(W_{tsfc})$$

RUM Refresher

RUMs assume that you pick the choice that gives you the most utility.

Example: A fisherman has S sites to choose from that are differentiated by the **profitability**, π_s, of each site.

He picks the kth site if it gives him the most utility.

$$U(\pi_k) + \varepsilon_k \geq U(\pi_r) + \varepsilon_r \text{ for all } k \neq r$$

Nested RUM Model

The probability of choosing site s, conditional on fishery/target choice fc as

$$\Pr ob(s \mid fc) = \frac{e^{\frac{\beta z_{sfc}}{(1-\sigma)}}}{\sum\limits_{r=1}^{N} e^{\frac{\beta z_{rfc}}{(1-\sigma)}}}$$

The probability of choosing fishery/catch target fc is

$$\Pr ob(fc) = \frac{e^{\phi y_{fc} + (1-\sigma)I_{fc}}}{\sum\limits_{fc=1}^{N_{fc}} e^{\phi y_{fc} + (1-\sigma)I_{fc}}}$$

The Nested RUM Model, cont.

where I_{fc} is called the inclusive value parameter and is obtained from

$$I_{fc} = \ln \left[\sum_{k=1}^{N_{fc}} e^{\frac{\beta z_k}{(1-\sigma)}} \right]$$

The inclusive value term captures information for all sites associated with fishery/target choice fc. I_{fc} can be thought of as the expected utility across the site choice conditional on the choice of fc.

RUM Model Comparison

Model 1:   Expectations on returns at fishing sites updated daily while at sea.

Model 2:   Expectations on returns at fishing sites formulated while at port not updated while fishing.

Empirical Results

	Updating	No Updating
Stage 1: Short Run		
WEALTH	0.121**	**0.094 * ***
Stage 2: Long Run		
WEALTH	0.0086**	**0.004***
INCVAL	0.457**	**0.649****

*5% level of significance
**1% level of significance

Sea Turtle Closure

All year: 30°N. to 44°N. between 137°W. and 173°E. (all of "swordfish fishery," part of "mixed fishery"

Seasonal closure: April/May, 23°N - 44°N and 6°N - 16°N between 137°W and 173°E.

Welfare Effects

	Sword	Mixed	Tuna
Model 1: Updating	$ 17,077	$5,672	$1,078
Model 2: No Updating	$14,522	$4,889	$1,258

Conclusions

Empirics

--   Longliners may have limited ability to update information on returns; there may be limited information sharing among longliners.

–   May provide evidence that many of the decisions made on a trip are made at port, which may add stability to fishery in that fishermen are not racing daily to new-found hot spots

Application

--turtle closure costly to longliners; results indicated differential effects across user groups